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(54) **Electric resistance heating element**

(57) A heater for air from a cross flow fan comprises a bottom wall, top wall and two end walls and a heating element comprising four resistance coils e.g. 31. Each coil is supported on a supporting former e.g. 41, which is respectively disposed longitudinally inside its corresponding coil with a slide fit and extends the full length of the coil so as to support the coil along its full length. A heat exchanger for a convector heater, in which each coil thereof is also supported on a respective former disposed longitudinally therein with a slide fit, is described.

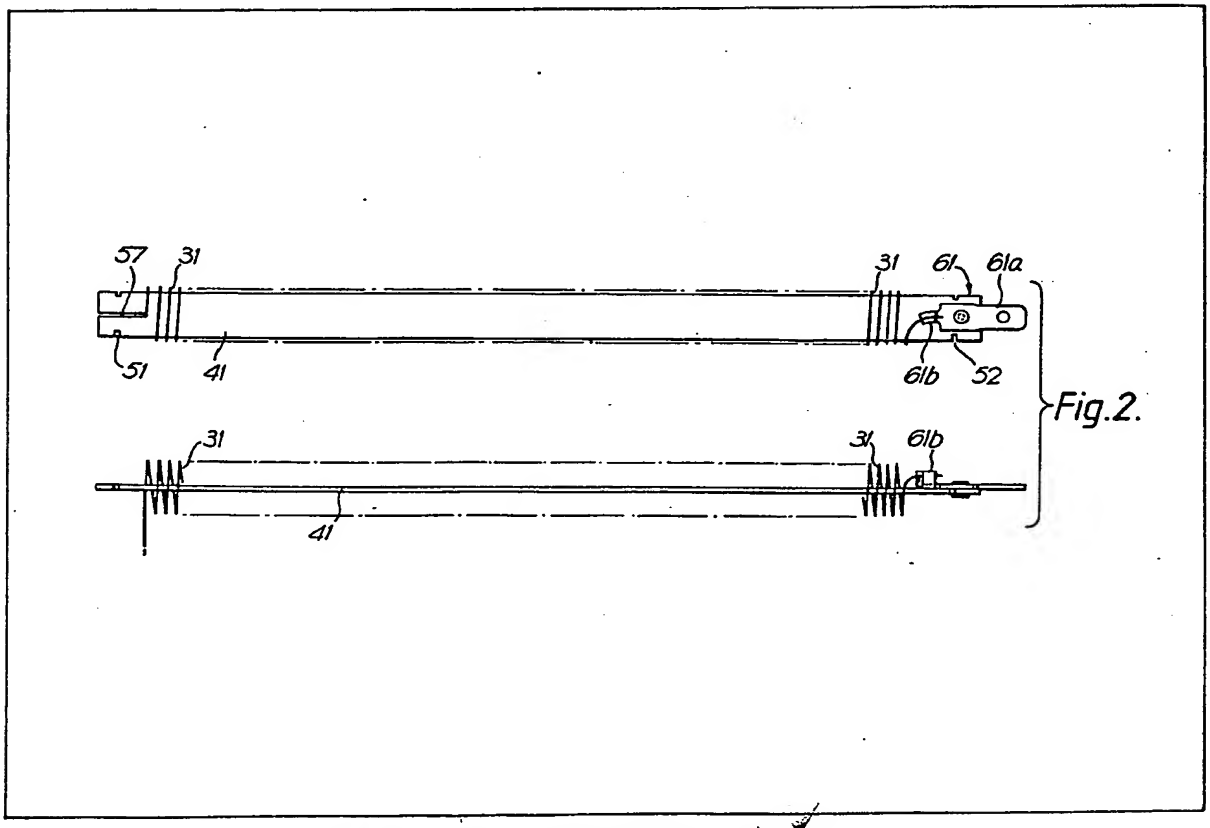

Fig.2.

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Fig.1.

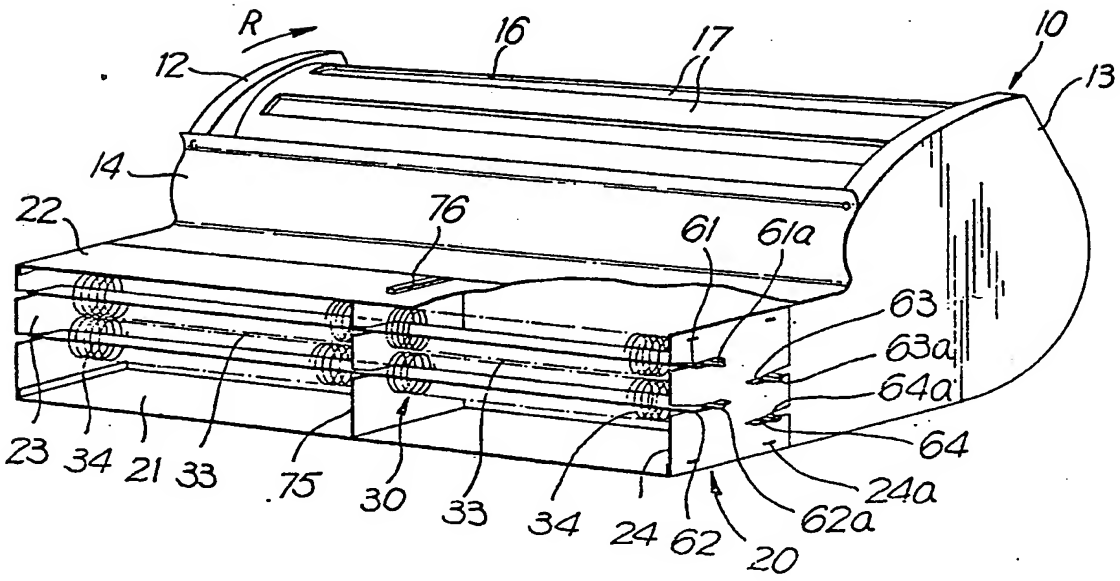

Fig.3.

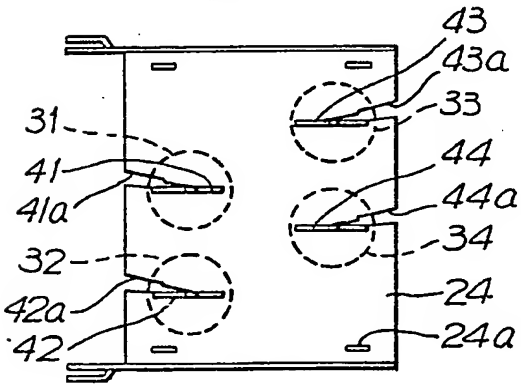

Fig.6.

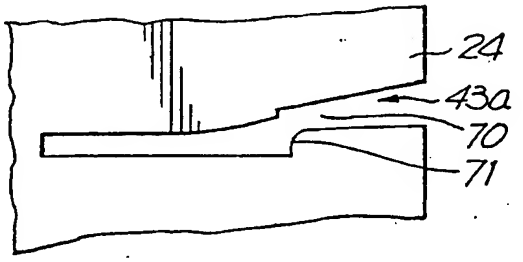

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Fig.2.

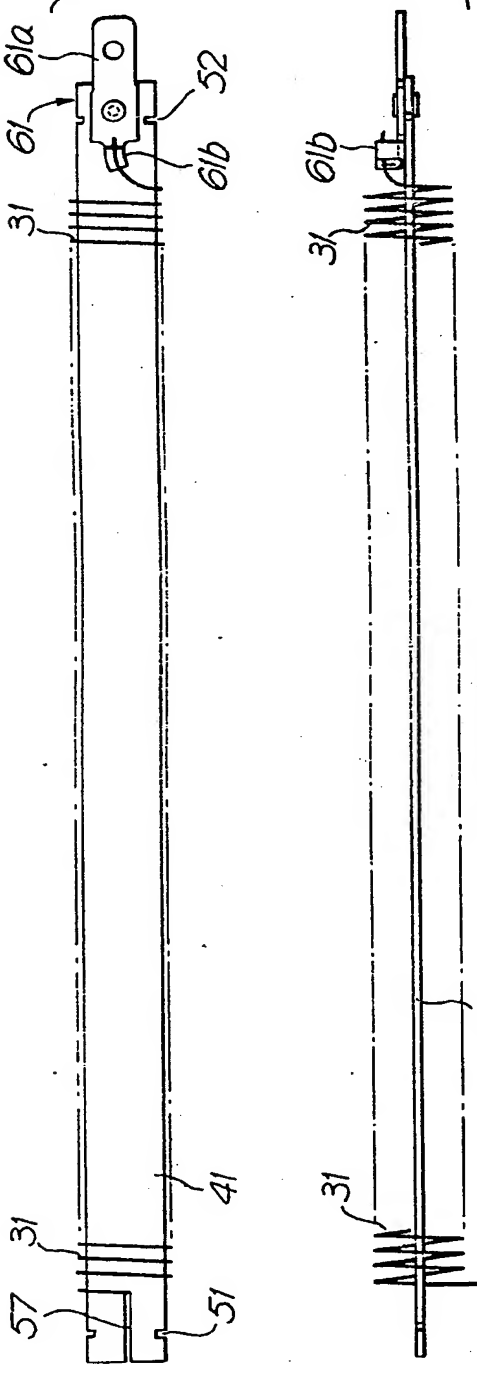


FIG 2

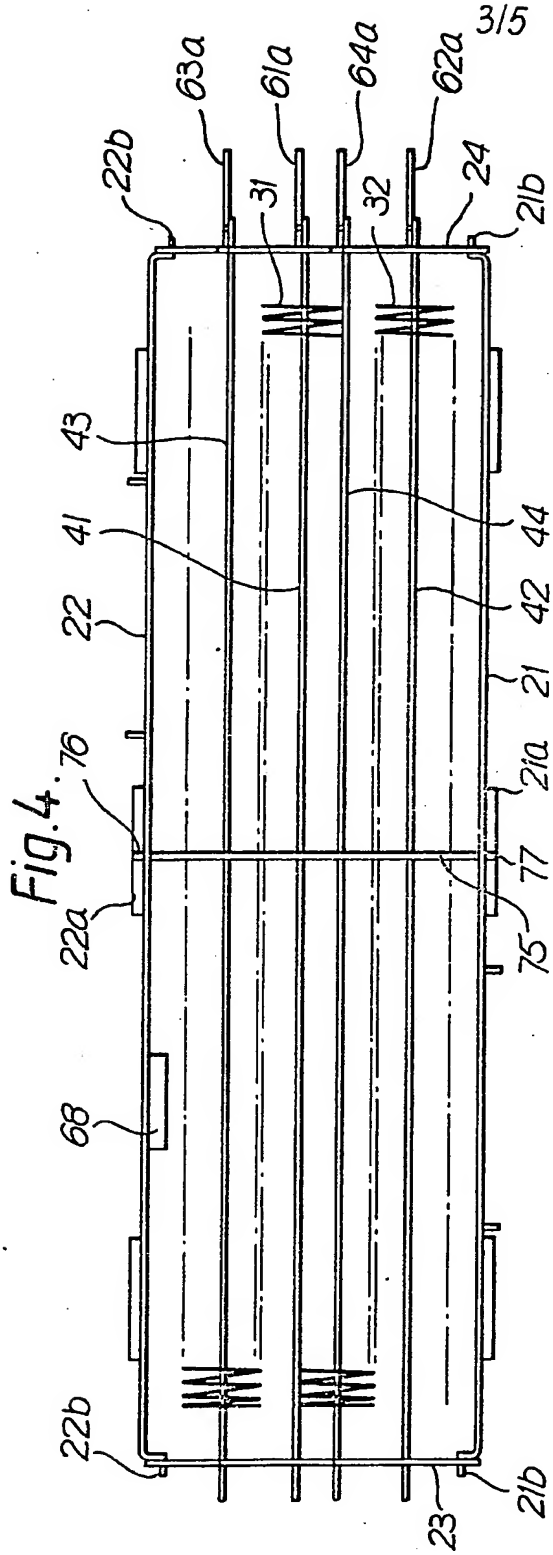

63a
61a
64a
62a
22b
31
32
24
21b
43
41
44
22
42
21
76
21a
77
22a
75
68
22b
23
21b

Fig.4.

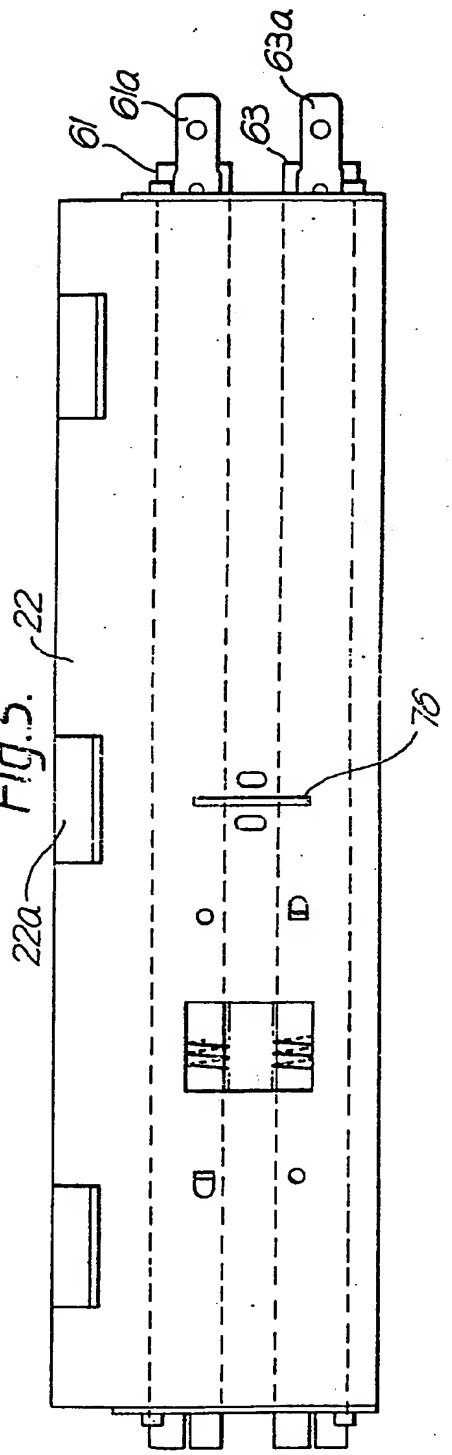

61
61a
63
63a
22
76
22a

Fig.5.

Fig.7.

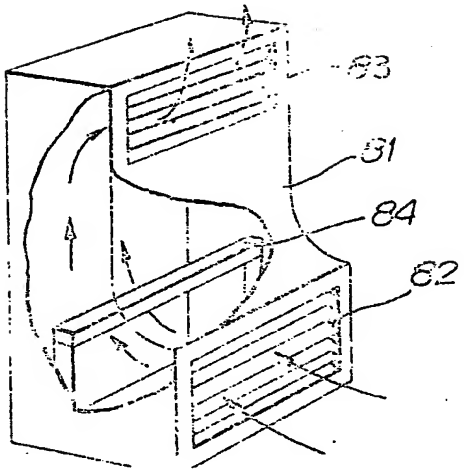
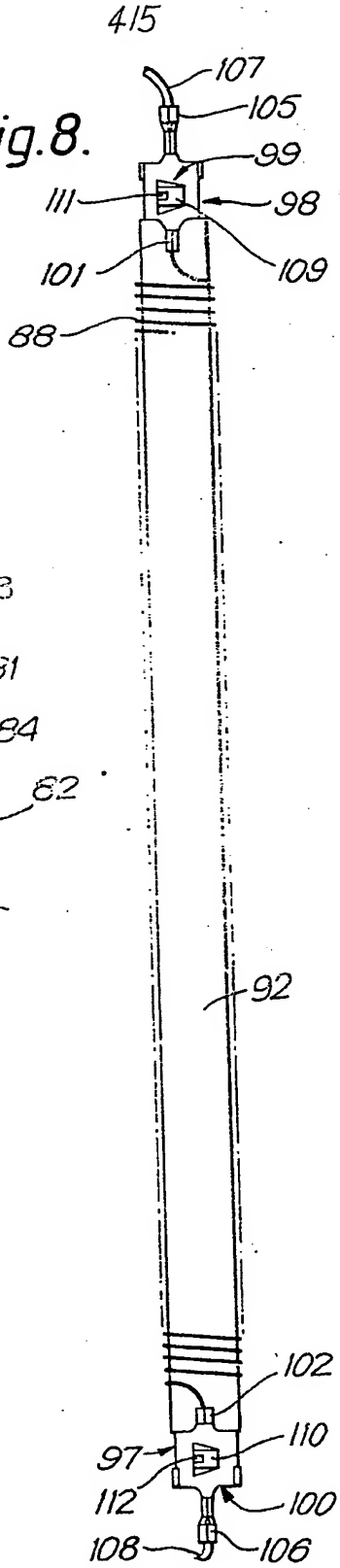


Fig.8.



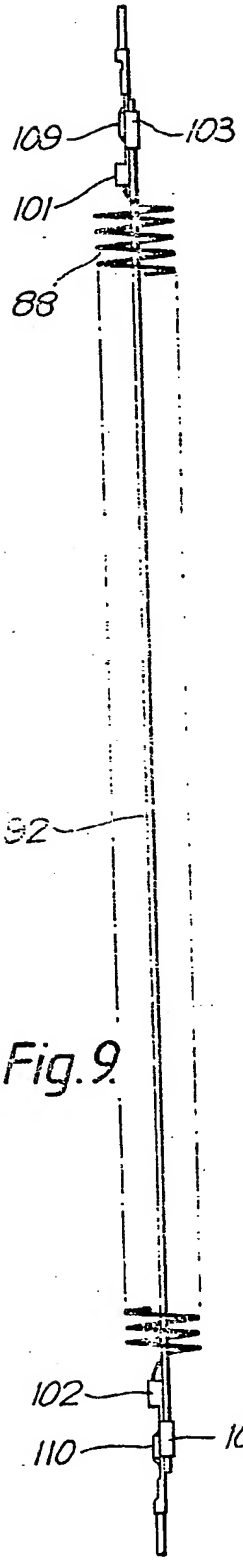


Fig.9

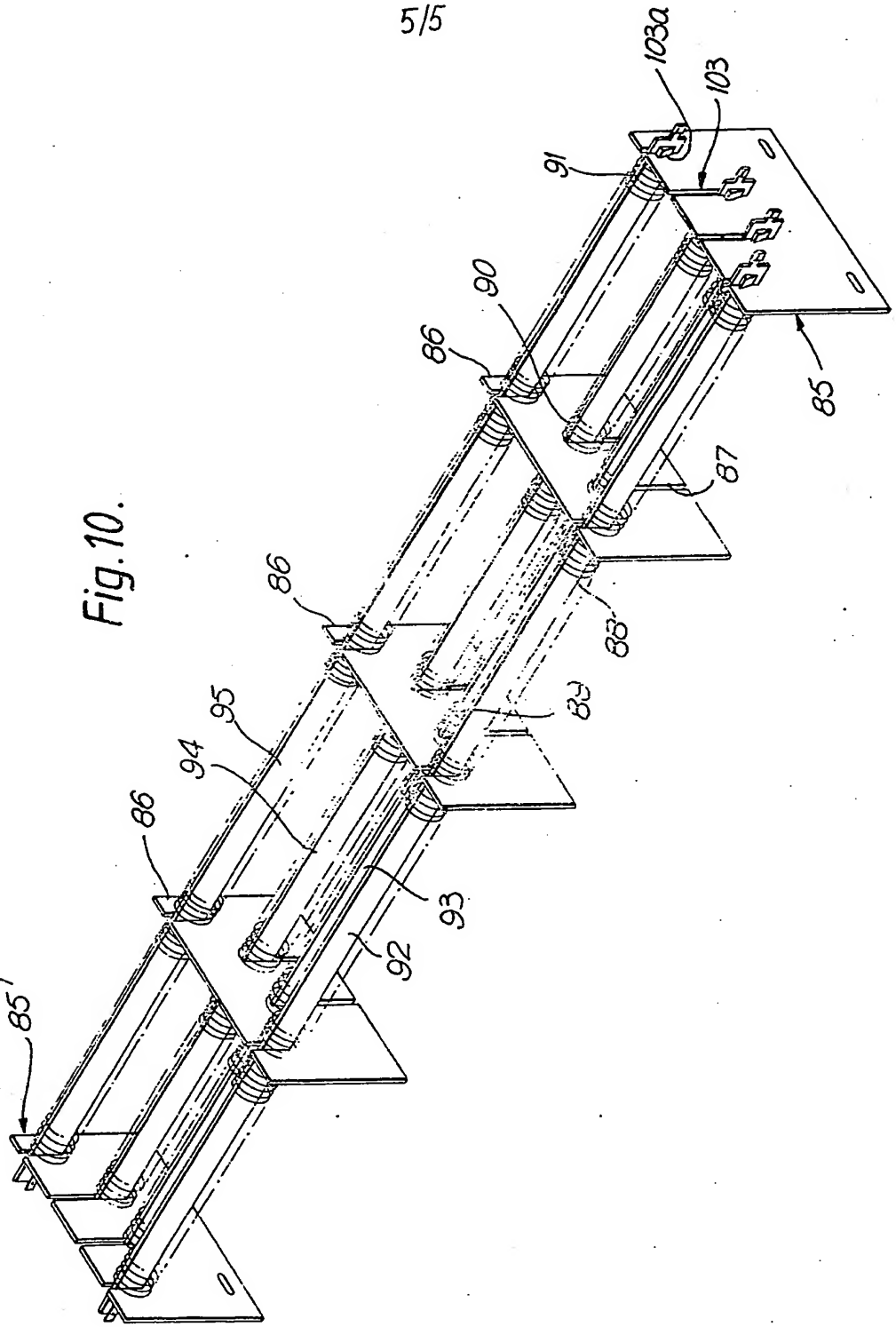


Fig.10.

SPECIFICATION

Heat exchanger

This invention relates to heat exchangers and more particularly to heat exchangers intended to be mounted adjacent the fan of a domestic room heater or in a forced or unforced convector heater.

A domestic room heater may employ a cross-flow or tangential fan which is a fan in which the rotor blades lie parallel to the axis of rotation of the rotor, these blades being located generally at the rotor's circumference. The air passes twice through the blades of the rotor in a direction always perpendicular to the rotor axis. A vortex is set up at the interior of the cylindrical rotor just upstream of where the air leaves the rotor for the last time. Examples of such cross-flow fans are given in British Patent Specifications 757 543 and 876 611.

The air outlet of cross-flow fans is generally about equal in length of the rotor, and usually this length is substantially greater than the height of the outlet so that the shape of the outlet can generally be regarded as being elongated in the direction of the rotor axis. The heat exchanger, which fits onto the air outlet of the fan, is then corresponingly elongated.

According to the present invention there is provided a heat exchanger comprising an electric resistance heating coil, a supporting former for the coil disposed longitudinally inside tie coil, the former having a width substantially greater than its thickness and extending the full length of the coil so as to support it along its full length, the coil being a sliding fit on its former, and a support structure adapted to support at least the ends of the former.

Typically, and particularly in the case of heat exchangers for use with cross-flow or tangential fans, the heat exchanger is of elongate form, the or each coil and the respective formers extend generally parallel to the direction of elongation and generally normally to flow of air therethrough during use thereof.

In the case of heat exchangers for convector heaters the support structure may comprise two former end suppot members arranged generally normally to the direction of the length of the former. Intermediate support members of electrically insulating material may be provided between the end support members.

For heat exchangers for use with cross-flow fan heaters the support structure may comprise a casing having a bottom wall, a top wall and two end walls forming an air guide for the air coming out of a fan outlet.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic overall front perspective view of a heat exchanger mounted on a cross flow fan to form the basic unit of a domestic room heater;

Fig. 2 is a top and front view on an enlarged scale of one of the supporting formers together with its corresponding coil, of the embodiment of Fig. 1;

Figs. 3, 4 and 5 are an end view, front and top view respectively of the heat exchanger of Fig. 1, on the same scale as Fig. 2;

Fig. 6 is an enlarged view of a mounting slot;

Fig. 7 shows, somewhat schematically and partly cut away, a convector heater;

Fig. 8 shows a side view of an embodiment of a supporting former and its corresponding coil and connectors for a convector heater such as Fig. 7;

Fig. 9 shows a plan view of the former and coil of Fig. 8, and

Fig. 10 shows a perspective view of a convector heater heat exchanger employing four formers and coils as shown in Figs. 8 and 9, the connectors being shown schematically.

Referring now to figs. 1 to 6 of the drawings, the basic unit of a domestic room heater is shown in Fig. 1. This heater unit comprises a cross-flow fan 10 at the outlet of which is mounted a heat exchanger 20. The cross-flow fan is known in itself and is only shown schematically. It comprises a casing formed of two flanged end walls 12 and 13 with a vortex former 14 screwed on one side to the flanges of these end walls, and a volute casing (not shown) screwed to the flanges on the other side of the end walls. A generally cylindrical rotor 16 having circumferential blades 17 which are parallel to its axis of rotation is mounted in this casing on bearings (not shown) provided on the end walls 12 and 13. A motor (also not shown) is mounted on one of the end walls for rotating the rotor 16 in the direction of the arrow R.

The heat exchanger 20 comprises a casing having a bottom wall 21, a top wall 22 and two end walls 23 and 24; this casing forms an air guide for the air coming out from the outlet of the fan 10. The heat exchanger is provided with electric heating element means 30 comprising a plurality (four in the present case) of resistance coils 31, 32, 33 and 34. A supporting former is provided for each of these coils, these formers bearing the reference numerals 41, 42, 43 and 44. Each former is disposed longitudinally inside its corresponding coil with a slide fit and extends the full length of its coil so as to support it along its full length. These formers are mounted in slots in the end walls 23 and 24 of the casing/air guide of the heat exchanger and extend across this casing/air guide on the inside thereof. There is also in intermediate support 75 similar to and walls 23 and 24 except that it is made of electrically insulating material preferably a Mica laminate such as that sold under the trade name FILAMIC or MULTIMICA and has upper and lower mounting tongues 76 and 77 which locate corresponding slots in the upper and lower walls 21 and 22.

Figure 2 shows a typical coil, namely the coil 31 (only the end portions being shown for clarity), supported by its corresponding former 41. The former 41 substantially wider than it is thick and is of flat strip form and has notches 51 at one end and further

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

notches 52 at the other end, these notches being designed to locate the former 41 relative to the end walls 23 and 24 and embrace the ends of mounting slots 41*a*, 42*a*, 43*a* and 44*a*. The length of this main section of the former 41, between its notches 51 and 52, is equal to the length of the heat exchanger between its end walls 23 and 24.

Each former is also provided with means for positioning the ends of its coil. As shown in Figure 2, these means take the form of a terminal 61*a* in the right-hand end (as viewed in Fig. 2) of the former 41 and a notch 57 in the left-hand end of this former. The wire constituting the coil 31 has its one end crimped in a crimping portion 61*b* of the terminal and its other end in the notch 57 and is thus held in position. The inner end of notch 57 is located in the main section of the former 41, on the inside of the notch 51. There is some clearance between the coil 31 and the end wall 23 of the heat exchanger.

The former 41 is a flat strip made of electrically insulating and heat resistant material such as mica or asbestos, preferably a mica laminate sold under the trade name FILAMIC or MULTIMICA. This strip is relatively thin (about 1 mm) and has a width that is substantially greater than the thickness (about 10 mm) and equal to the inner diameter of the coil 31 so that the strip 41 fits inside the coil 31 with a slide fit and supports the coil along its entire length.

The electrical heating element means 30, made up by the four coils 31 to 34, comprises two separate heating elements, one of which is made up by the front coils 31 and 32 and the other of which is made up by the coils 33 and 34. To this end the front coils 31 and 32 are constituted by a single resistance wire whose two ends are referenced 61 and 62 in Fig. 1 and the rear coils 33 and 34 are constituted by a single wire whose ends are referenced 63 and 64. The ends 61 to 64 are located on the outside of the heat exchanger casing and each have a metal connection terminal 61*a* to 64*a* riveted thereto and connected to the coil end. Terminal 61*a* is clearly seen in Fig. 2 and has crimped portion 61*b* physically and electrically connecting with this end of the wire 31. The terminals are intended to be connected to the mains supply via an appropriate switch for turning on either one or both heating elements. One terminal of each heating element, say terminals 62*a* and 64*a*, can be connected to a common terminal. The electrical connections and switch arrangements are well known and will not be described.

Taking the pair of coils 31 and 32 as an example, the resistance wire making up this pair extends from its terminal 61*a* as coil 31 until is reaches the notch 57; the wire then passes through the notch 57 to the corresponding notch in the former 42; the coiled wire then extends to the right-hand end of the former 42 and is held crimped in the portion of connection terminal 62*a*.

It is usual practice to mount a thermally operated cut-out on the heat exchanger of a domestic room heater, in order to cut off the supply of power in the case of over heating. Such cut-outs are well known and one is indicated schematically by reference numeral 68.

Figures 3, 4 and 5 are end, front and top views respectively of the heat exchanger of Fig. 1 and show the disposition of the four coils 31 to 34 with their formers 41 to 44. As can be seen, the coils and formers are located at the four corners of a diamond whose front and rear sides are generally parallel to the front and rear sides of the end walls of the heat exchanger.

Cut out tongues such as 21*a* and 22*a* locate on the front edges of the volute casing and the vortex former respectively to assist in mounting the heat exchanger on the fan outlet.

The end walls 23 and 24 have slots such as 24*a* which locate on tongues such as 21*b* and 22*b* of the top and bottom walls 21 and 22 respectively. The tongues are subsequently deformed, such as by twisting, to permanently secure the parts together and make a rigid structure.

In Figs. 1 to 6 of the drawings ot has been assumed that there are four coils. This is not necessary as there could be a number of coils greater or less than four, although the configuration illustrated shows the much preferred size and arrangement having regard to the size and shape of the outlet, the number of coils and the size of the coils and their relative staggered positions. The width of the air outlet is about 50 mm.

In the embodiment shown in Figs. 1 to 6 of the drawings, the formers 41 to 44 are all parallel to the bottom and top walls 21 and 22 of the heat exchanger. The formers are also generally parallel to the direction of the air flow coming out of the fan 10 and passing through the heat exchanger 20. These formers 41 to 44 can however be disposed at a slight angle of up to 10° for example with respect to their positions as shown in the drawings. The exact angle can be adjusted to obtain maximum cooling of the coils by the air passing through them.

The casing of the cross flow fan 10 is made of metal, preferably that sold under the trade name ZINTEC. Similarly the bottom and top walls 21 and 22 of the heat exchanger 20 could also be made of the same sheet metal as indeed is the end wall 23. Care must be taken to ensure that the wire making up the resistance coils can never come into contact with the end wall 23. The end wall 24, where the electric connections are made, is made of an electrically insulating material such as polyester glass for example.

Figure 6 shows in greater detail on an enlarged scale one mounting slot 43*a* in the end wall 24. It has a tapering entrance 70 leading first to a step 71 and then to an inner mounting portion 72. The upper edge 73 of the mounting portion 72 is curved upward slightly. Such a slot enables the coil former 43 to be introduced sideways into the entrance and to cross the step until it snaps into position in the mounting portion where it is held by the step 71 so it cannot fall out with the notches 52 embracing the ends of the inner mounting portion 72.

The heating means 30 is manufactured by preforming the coils 31, 32, 33 and 34 on forming mandrels and subsequently sliding the coil formers 41 to 44 into the respective coils. The connection terminals 61*a* to 64*a* are then fixed to the ends 61 to 64 of the formers 41 to 44 and the formers with their coils in

position are then snapped into the mounting slots such as 41*a* to 44*a*.

The basic structure of a convector heater is shown in Fig. 7. It comprises a housing 81 with openings 82 and 83 for air passage through the housing from the bottom to the top, as indicated by the arrows. A heating element 84 is arranged towards the base of the housing 81 and warms the air in the housing. The warm air rises and as it rises cold air is drawn into the housing via opening 82. The housing 81 thus acts as a chimney and creates a continuous current of warm air which leaves it via openings 83. The interior of the housing may be suitably shaped (curved) to achieve optimum air-flow characteristics.

The heating element 84 is a heat exchanger shown in more detail in Fig. 10. It comprises two end supports 85 and 85' and, in this embodiment, three intermediate supports 86. The number of intermediate supports is dictated by the length of the heat exchanger. The heat exchanger is provided with electric heating means comprising a plurality (four in this case) of resistance coils 88, 89, 90 and 91. A supporting former is provided for each of these coils, the formers bearing the reference numerals 92, 93, 94 and 95. Each former is disposed longitudinally inside its corresponding coil with a slide fit and extends the full length of its coil so as to support it along its full length. The resistance coils may be made of wire of a circular cross-section.

The formers 92, 93, 94 and 95 are mounted in slots such as 103 in the end supports 85 and 85', and extend through respective slots 87 in the intermediate supports 86. Two of the slots 87 extend from one side of the intermediate supports 86, whereas the other two slots extend from the opposite side, whereby in the assembled state the formers hold the intermediate supports in position. The intermediate supports 86 are made of an electrically insulating material such as a mica laminate sold under the trade name FILAMIC or MULTIMICA.

Figs. 8 and 9 show a typical coil; namely coil 88 (only the end portions being shown for clarity), supported by its corresponding former 92. The former 92 is substantially wider than it is thick and is of flat strip form. It has notches 97 at one end, and notches 98 at the other end. The notches 97 and 98 are provided for the securement of spade-type connectors 99 and 100 to the former 92. The connectors 99 and 100 each have a pair of flanges 103, 104 respectively which are crimped about the former 92 at the notches 98 and 97 respectively, thereby retaining the connectors on the former. The connectors have outer portions 105, 106 adapted to be crimped onto leads such as 107 and 108 respectively.

Each connector is also provided with means for positioning the ends of the former 92 relative to the end supports 85 and 85'. As shown in Figs. 8 and 9, these means take the form of tangs 109 and 110, and notches 111 and 112, respectively, in the tangs 109 and 110. The slots 103 in the end supports 85 and 85' have recesses 103*a* in which the tangs 109 and 110 engage, whereby the connectors snap fit into the slots. The notches 111 and 112 in the tangs are such that, in use of the connector/former/coil assembly, they embrace a respective portion of an end support member and prevent longitudinal movement between the former and the end support member.

The wire constituting the coil 88 has one end crimped in a crimping portion 101 of terminal 99, and the other end crimped in a crimping portion 102 of the terminal 100. There is thus some clearance between the coil 88 and the end supports 85 and 85' of the heat exchanger.

The former 92 is a flat strip made of electrically insulating and heat resistant material such as mica or asbestos, preferably a mica laminate sold under the trade name FILAMIC or MULTIMICA. This strip is relatively thin, for example about 1 mm, and has a width that is substantially greater than the thickness, for example about 10 mm, and equal to the inner diameter of the coil 88 so that the strip 92 fits inside the coil with a slide fit and supports the coil along its entire length.

The heat exchanger is thus made up of four coils which may comprise four separate heating elements, or may be interconnected to comprise two separate heating elements such as by connecting the terminal of coils 88 and 89, and connecting the terminals of coils 90 and 91, at the end support 85'. The terminals, such as 99 and 100, are intended to be connected to the mains supply via an appropriate switch for turning on the desired number of heating elements. The electrical connections and switch arrangements are well known and will not be described. It is also usual practice to mount a thermally operated cut-out (not shown) on the heat exchanger of a domestic room heater, in order to cut off the supply of power in the case of overheating.

Whereas in the embodiment shown in Fig. 10 the formers and the slots such as 103 in the end supports are vertically orientated, the formers may alternatively be disposed at a slight angle with respect to their positions shown in the drawings by appropriate orientation of the slots. The orientation of the formers is dictated by the direction of air flow through the heater housing, and they are generally parallel to the direction of air flow. The optimum orientation is that when maximum cooling of the coils is achieved by air passing through them. Instead of anoing the slots 103 the same effect can be obtained by correspondingly angling the connection between the end supports 85 and 85' and their mounting brackets 96.

The overall construction of a heat exchanger is such as to permit the maximum air flow over the coils thereof.

Generally the end supports 85 and 85' are made of an electrically insulating material such as a polyester glass, for example. In arrangements where two coils are interconnected at end support 85' to form a single heating element, the end support 85' can be made of sheet metal such as sold under the trade mame ZINTEC. Such interconnection may be achieved by arranging that the two coils are wound from a continuous wire, and the connectors adjacent end support 85' are replaced by simple notches extending axially in the respective formers, the wire then passes through one notch to the corresponding notch in the adjacent former as described above with reference to Fig. 2.

The heat exchanger is made by preforming the coils 88, 89, 90 and 91 on forming mandrels and subsequently sliding the coil formers 92, 93, 94 and 95 into the respective coils. The ends of the coils are then crimped as at 101, 102 to the connectors such as 99, 100, which have been crimped onto the formers. The formers with their coils in position are then slotted into place in the mounting slots of the support structure comprising end supports 85 and 85' and intermediate supports 86, snap fitting into the end support slots as described above and holding the intermediate supports in position by virtue of slotting there into from two opposite directions.

Whereas the heat exchanger has been described as having a plurality of coils, such as four, it can alternatively have only a single coil.

Whilst the convector heater described above does not have a fan, the heat exchanger of Fig. 10 can alternatively be employed with a convector heater having a fan (a forced convector heater).

The connection terminals, such as 61*a* employed in the fan heater described with respect to Figs. 1 to 5 may be replaced by spade type connector terminals as described with reference to Figs. 8 to 10 for a convector heater.

CLAIMS

1. A heat exchanger comprising an electric resistance heating coil, a supporting former for the coil disposed longitudinally inside the coil, the former having a width substantially greater than its thickness and extending the full lengthof the coil so as to support it along its full length, the coil being a sliding fit in its former, and a support structure adapted to support at least the ends of the former.

2. A heat exchanger as claimed in claim 1, and of elongate form, the coil and the former extending generally parallel to the direction of elongation and generally normally to flow of air therethrough during use thereof.

3. A heat exchanger as claimed in claim 1 or claim 2, wherein the support structure includes two former end support members arranged generally normally to the direction of the length of the former.

4. A heat exchanger as claimed in claim 3 further including at least one support member intermediate the end support members, the at least one intermediate support member being of an electrically insulating material.

5. A heat exchanger as claimed in claim 3 or claim 4, wherein the ends of the former extend through corresponding slots in the end support members and are prevented from longitudinal movement relative to the end support members.

6. A heat exchanger as claimed in claim 5 wherein means are provided to prevent the former moving sideways out of the slots in the end support members.

7. A heat exchanger as claimed in claim 6, wherein the means comprises an electrical connector on the former end.

8. A heat exchanger as claimed in claim 7, wherein the connector has a tang which locks the former in the slot.

9. A heat exchanger as claimed in claim 7 or 8, wherein the slot is so shaped in relation to the cross-section of the connector that the former is a snap fit in the slot.

10. A heat exchanger as claimed in claim 8, wherein the former is prevented from longitudinal movement relative to the end support members by means of notches in the connector tangs, which tang notches embrace respective portions of the end support members.

11. A heat exchanger as claimed in any one of the preceding claims including four generally parallel formers each supporting a respective coil.

12. A heat exchanger as claimed in claim 11 as dependent on claim 4, including three intermediate support members.

13. A heat exchanger as claimed in claim 1 or claim 2, wherein the support structure comprises a casing having a bottom wall, a top wall and two end walls forming an air guide for the air coming out of a fan outlet in use of the heat exchanger, and wherein there are a plurality of the electric resistance heating coils with a respective supporting former for each coil disposed longitudinally therein, each former being mounted on the end walls of the air guide and extending across the air guide on the inside thereof.

14. A heat exchanger as claimed in claim 13 wherein at least two supporting formers and associated coils are disposed one above the other and one behind the other in relation to the air flow through the guide.

15. A heat exchanger as claimed in claim 13, or claim 14, wherein each former has a notch adjacent one end for positioning the pertaining end of the coil relative to the former.

16. A heat exchanger as claimed in claims 13 or 14, wherein an end of a former extends through a slot in the corresponing end wall and is prevented from longitudinal movement relative to the end wall.

17. A heat exchanger as claimed in claim 16, wherein the slot is open-ended and the corresponding end of the former has been introduced sideways into the slot.

18. A heat exchanger as claimed in claim 17, wherein the slot is so shaped in relation to the cross-sectional shape of the former that the former is a snap-fit in the slot.

19. A heat exchanger as claimed in claim 17 or claim 18, wherein the former is prevented from axial movement relative to the end wall by means of a notch in at least one edge of the former, which notch embraces an end of the slot.

20. A heat exchanger as claimed in any one of the preceding claims, wherein the or each coil has been pre-wound on a mandrel, removed from the mandrel and slid onto the pertaining former.

21. A heat exchanger as claimed in any one of the preceding claims, wherein the or each former is made of a Mica laminate.

22. A heat exchanger as claimed in any one of the preceding claims, wherein the or each former has a thickness of about 1 mm. and a width of about 10 mm.

23. A heat exchanger substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 6 of the accompanying drawings.

24. A fan heater embodying a heat exchanger

assording to any one of claims 13 to 19 and 23, or claims 20 to 22 as appendant to claims 13 to 19.

25. A convector heater heat exchanger substantially as herein described with reference to and as illustrated in Figs. 8 to 10 of the accompanying drawings.

26. A convector heater embodying a heat exchanger according to any one of claims 1 to 12 and 25, or claims 20 and 22 as appendant to claims 1 to 12.

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